

Perspective

Chester Step Test as a Reliable, Reproducible Method of Assessing Physical Fitness of Disaster Deployment Personnel

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Field disaster response typically is strenuous, difficult work, both physically and mentally.¹⁻³ Although hard evidence is lacking, it may be inferred that responders lacking appropriate physical fitness are at increased risk of injury or compromising safety operations during a deployment. This problem may be amplified depending on where the disaster has occurred. For example, deploying to a large-scale international disaster, particularly in a developing country with austere conditions, often involves the additional variable of limited or nonexistent local health care. Should a disaster team arrive with less-than-fit personnel, there is a risk of having the capabilities of the team deteriorate steadily at best and potentially life-threatening complications among its personnel at worst. In reporting results from monitoring the health of qualified September 11, 2001 World Trade Center disaster responders, Perritt and colleagues found that more than one-third reported at least one injury or illness, sustained during response activities, which required medical treatment.⁴ At least one-third of these individuals required treatment off-site, which may not be possible in remote disaster locations.

The idea of fitness requirements may seem intuitive. With respect to disaster response, “fitness for duty” should be understood to encompass an appropriate skill set and credentials, physical fitness, psychological fitness, and absence of certain high-risk or high-maintenance health conditions. In many cases, however, basic physical fitness standards that are used in other industries have not been adopted by the disaster response community. An easy comparison to make is with the fitness of military personnel, who also operate in austere and dangerous environments. Members of the US military are under strict requirements as to fitness to be cleared for military field operations. It is unclear why the benefits of such physical fitness standards adopted by military personnel have not been adopted by disaster responders.⁵ There has been considerable focus on the mental health and

well-being of potential employees.⁶ In addition, much has been written regarding disaster medical tourism as a phenomenon occurring shortly after disasters, including the 2010 Haiti earthquake.^{7,8}

Burkle, among others, has examined the need for standards for foreign medical teams and the need to demonstrate competencies through examination or experience.⁹ Redmond and colleagues developed a formal register for medical staff in the United Kingdom to ensure they are “fit to go” without significantly depleting national health service resources.¹⁰ On behalf of the World Health Organization, Norton et al have proposed minimum standards and classifications for foreign medical teams activities to include capacity and workload capabilities.¹¹ Although many of the reports examine fitness with respect to the teams’ physical readiness for the mission they purport to serve, there are few data regarding the actual physical fitness of teams and whether this has been considered in their selection criteria.

In the United States, the National Disaster Medical System, a division of the Department of Health and Human Services, oversees disaster medical assistance teams (DMATs). These DMATs deploy to federally declared disasters, predominantly within the country but occasionally outside the continental United States. These teams are tasked to be fully self-sufficient within a disaster zone for 72 hours and then continue to be self-sufficient for a total of 14 days, after a resupply of food, water, and other basic supplies. The DMATs operate in active disaster zones, typically in severe, demanding conditions. Although there are no clear National Disaster Medical System centrally mandated standards, some of the DMATs have adopted their own fitness criteria. The Arizona-1 DMAT has adopted the following minimum fitness clearance requirements for deployment¹²:

- Walk/run 1 mi in 16 minutes
- Climb three flights of stairs without being short of breath
- Carry a 75-lb tote bag for 100 ft with another person

This fitness requirement has not been validated to our knowledge. Following the terrorist attacks of September 11, 2001, some researchers have proposed minimum “fitness for duty” criteria, which include personal risk factors; hazards related to the specific disaster zone; and disaster-specific risks such as toxins, environmental hazards, and safety concerns.¹³ These “fitness for duty” criteria are proposed with the understanding that many of the injuries sustained by responders can be minimized by attention to their fitness and capabilities. Although the most attention has been paid to the respiratory consequences of the airborne toxins that permeated the grounds of the fallen World Trade Center towers, popularly known as Ground Zero, there has been little thought given to the numbers of injuries that could have been avoided if better physical fitness requirements for responders had been in place.

Occupational health practices have been a more integrated part of disaster responder preparedness and response activities, particularly since the September 11 terrorist attacks. Most of the work, however, has focused on the psychosocial realm, with

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particular attention devoted to posttraumatic stress disorder and mitigating practices such as psychosocial first aid. Again, little research has been done regarding best-practice models for managing physical aspects of responder injury and illness.

The Red Cross has examined injury and illness patterns in its responders to various disasters from 2008 to 2012 and found that categorizing disasters into disaster relief operation levels, measured by operational cost and disaster type, allowed for a reliable predictor of rates of responder injury and/or illness. The higher the disaster relief operation level, the greater the numbers and severity of injuries and illnesses.¹⁴ This seems to imply that physical fitness levels would have a direct effect as well, limiting worker stamina and therefore susceptibility to injury.

An immediate issue is encountered when maximal tests of exercise capacity (typically related to strength, function, or aerobic/anaerobic capacity) are drawn upon to measure the physical tolerances, abilities, or both of nonathletic populations. The nonathletic individual's lack of experience, or indeed, need to perform at such demanding levels or workloads implies that maximal tests would be an inappropriate way to test a nonathletic individual's performance. During the process of measuring and determining the fitness capacity of a medical professional working in a disaster setting, the priority in determining the individual's fitness rests in establishing to what extent he or she can tolerate the work rate that exists within a level of activity that may be expected of his or her role; this rarely if ever draws upon a need to sprint, engage in plyometric jumps, or exert force against maximal external loads. The focus is on how the individual responds to increasing physiological and aerobic stresses.

The Chester step test (CST) is an incremental load test that was established by Kevin Sykes of the University of Chester (Chester, UK) to determine the fitness (and predict the VO_2 max) of firefighters in the United Kingdom, United States, and Asia and is a submaximal measure of aerobic capacity.¹⁵ An initial step rate in the test is 15 steps per minute onto a box varying in height (depending on age and physical activity history), and every 2 minutes the tempo of the stepping rate (set by a recorded metronome and verbal instructions) increases by 5 steps per minute. The CST is completed when the subject reaches 80% of the age-estimated maximum heart rate. Although not as precise as maximal exercise testing, the CST has been accepted widely as a reliable method of recording a subject's fitness without the investment of time, cost, and effort typically associated with maximal laboratory-based performance tests. Although challenging the test's ability to accurately predict VO_2 max, Buckley et al did endorse that the CST has a highly reliable test/retest measure of aerobic capacity, exercise tolerance, and measure of change within such parameters.¹⁶ Sykes and Roberts reported a high correlation ($r = 0.92$) between VO_2 max and CST ($P < 0.001$).¹⁵

The simplicity of the test is arguably its main attraction in this instance, because it does not require any prior exercise performance experience or preparation. The amount of equipment required to complete the test is minimal and a full responder team could be assessed in a brief period, possibly even simultaneously.

We propose that this simple and easily reproducible CST be used to determine the physical fitness of potential deployees' for deployment.¹⁵ Although the CST is not as precise as maximal exercise testing, we believe that it is an acceptable method of recording a nonathletic subject's fitness without excessive time, cost, and effort requirements on the part of the subject or the assessment team itself.¹⁶ Bennett and colleagues suggest that the CST tool has high test/re-test reliability and is therefore a good method of tracking changes in cardiovascular fitness.¹⁷

Recommendations

We believe that using the CST to gauge the physical fitness of potential disaster team responders in advance of deployment is a useful adjunct to other wellness programs. Suggesting CST results that are potentially compatible with specific performance roles in the disaster sphere is outside the scope of this article.

We strongly suggest that response agencies consider the potential roles that they fill in grading the predicted work intensity of such roles and complete CST assessments to determine their responders' age-appropriate fitness rating category (excellent, good, average, below average, poor) as outlined by Sykes and Roberts and deploy accordingly.¹⁵ Further work is required to develop guidelines outlining personal medical conditions that may preclude volunteers from deployment and an appropriate ethical framework for excluding unfit volunteers from disaster response operations.

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